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the Taxineae, Podocarpineae, and many Cupressineae have two cotyledons, and that each cotyledon (Podocarpineae being excepted) contains one vascular strand and the primary root is diarch. Among the Abietineae, however, in which polycotyledony prevails, each cotyledon has a single vascular strand, but the number of poles of the primary root holds no obvious relation to the number of cotyledons.

In summarizing the evidence of splitting, the authors add the following testimony: the occurrence of partially split cotyledons, the frequent obvious grouping of cotyledons, and the cases of transition. *Pinus contorta Murrayana* may be selected as an illustration of the last case, in which form three entire cotyledons were found, one of them much larger than the other two and containing two entirely distinct vascular strands. The authors speak of this as a case of one whole cotyledon and two half-cotyledons. Trouble of course comes with the higher numbers of cotyledons, and at this point the explanation offered is not clear. It is acknowledged that in some cases an increased number of cotyledons may result from the appearance of extra primordia, which represent the displacement of foliage leaves from the first stem node to the cotyledonary node.

The general summary of facts contains the following items: the occurrence of more or less complete cotyledonary tubes (over 20 species cited); the existence of cases of incomplete splitting (4 species cited); the general presence of cotyledonary resin ducts (several in araucarians, two in 12 species cited, one in 6 species, and none in 6 species or more); the occurrence of 4-8 vascular strands in each cotyledon of *Araucaria*, and of one strand in the cotyledons of *Tsuga*, *Abies*, *Picea*, *Cedrus*, *Pinus*, and *Larix*; the occurrence of mesarch structure in occasional cotyledons of *Tsuga canadensis*, *Pinus Pinea*, and *P. Gerardiana*.

SHAW²⁶ has investigated the seedling of *Araucaria Bidwillii*, a tuberous species and one not studied by HILL and FRAINE. He finds that the cotyledonary vascular strands are very numerous and variable (12 to 16), that the poles of the root are equally variable (5 to 7), and that there is a very confused connection between the two. The protoxylem groups of the root are gradually reduced until the diarch condition is finally attained.—J. M. C.

The Piccard rotation experiments.—HABERLANDT²⁷ has repeated PICCARD's rotation experiments,²⁸ for which he used the seedlings of *Vicia Faba*, *Lupinus albus*, and *Phaseolus multiflorus*. He characterizes PICCARD's conception as good, but the execution of the experiments and the interpretation of the results as faulty.

He claims to have eliminated all PICCARD's technical errors by devising a very substantial and accurate centrifuge, and by securely fastening the seedlings

²⁶ SHAW, F. J. F., The seedling structure of *Araucaria Bidwillii*. *Annals of Botany* 23:321-334. pl. 21. figs. 6. 1909.

²⁷ HABERLANDT, G., Ueber die Verteilung der geotropischen Sensibilität in der Wurzel. *Jahrb. Wiss. Bot.* 45:575-600. 1909.

²⁸ PICCARD, AUGUST, Neue Versuche über die geotropische Sensibilität der Wurzelspitze. *Jahrb. Wiss. Bot.* 40:94-102. 1904.

with plaster of Paris, at the same time supplying them with sufficient moisture. The roots were placed at an angle of 45° with the axis, as were PICCARD'S. While PICCARD used 20-40 rotations per second, HABERLANDT found it necessary to use only 5-20.

If the tips of the roots extended 1.5^{mm} or more beyond the axis, they always bent in the direction according with the irritability of the tip; if 1^{mm} or less, the curvature was determined by the irritability of the growing zone. HABERLANDT points out (what he says PICCARD and his critics have failed to notice) that where the root tip extends 1.5^{mm} beyond the axis, the growing zone receives on the average greater stimulation than the root tip, the centrifugal acceleration of the growing region, by reason of its greater length, being 2.8-3.9 times that of the tip. This, of course, is due to the considerable length of the growing zone. HABERLANDT never gets the S curve described by PICCARD. He concludes that $1.5-2^{\text{mm}}$ of the root tip, in the forms worked with, is very sensitive to gravity and to centrifugal acceleration. The growing zone is likewise sensitive, but far less so than the tip. The marked geotropic sensitiveness of the tip corresponds to the well-developed statolith apparatus of the cap, while the slighter sensitiveness of the growing zone is due to the rather poorly developed statolith starch of the periblem in that zone.

He finds that the geotropic irritability of the growing zone is manifested with accelerations as low as 0.25 gravity, and therefore that it comes into play in ordinary geotropic response, exactly opposite to NEMEC'S conclusion.

HABERLANDT also conducted a set of decapitation experiments, making full allowance for the shock effect of decapitation, which accord fully with the results by the PICCARD method. He concludes that all these results are quite in harmony with the statolith theory.—WM. CROCKER.

Plant proteases.—VINES has now for more than ten years devoted his attention to the proteases of plants and he has made the field practically his own. The conclusions he has from time to time announced mark periods in the development of the problem. The last paper by this author²⁹ should be considered in two parts, the first of which deals with his latest results, while the second constitutes a review of the earlier investigations, together with final conclusions.

The papain or papayotin of the latex of papaw, which has long been known to digest proteins, was shown by MARTIN to be both peptic and peptolytic. It was therefore designated a tryptic enzyme. The discovery that other vegetable extracts (germinated lupin, castor-bean, some fruit juices, malt, yeast) had a like action, led to the notion that plant proteases in general are tryptic. This conception, although a generalization from too limited data, was an advance, as it supplanted the prevalent idea (also resting upon an insecure foundation) that plant proteases are peptic. Following up his work on tryptic extracts from various sources, VINES has finally come to believe that the proteases of plants are of two sorts, the peptases and the ereptases. This conviction has been further fixed

²⁹ VINES, S. H., The proteases of plants. VI. *Annals of Botany* 23:1-18. 1909.